d. Policy decision to favor military or non-military management of programs of essentially ambiguous character.

<u>Question</u>: Within these or other relevant criteria, what decisions are in order with respect to assigning management responsibility for current or planned parts of the national space program?

IV. SCIENCE PROGRAMS

One of the prime objectives of the national space program is the advancement of science. Since space activities have approached the frontiers of practically all of the sciences, public support of space activities will mean support of research in general.*

Maintenance of a vigorous and balanced scientific experimental program depends upon timely selection of desirable undertakings: proposed experiments must be explored in detail for their scientific merit, carefully related to existing physical theory, supported by adequate preliminary investigation in ground laboratories, and properly exploited in post-experiment assessment by both theoretical and laboratory studies, with results being expeditiously and widely disseminated.

> Question: Do present means for selecting space experiments adequately (Sec. 203(a)(2) of the Act) "arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles"?

In the short term, there is a backlog of experiments, largely generated by the International Geophysical Year satellite effort, yet to be carried through. At least to this extent, then, the physical capabilities for space flight still stand deficient. Construction of a solid future position in encouraging further experimental innovations will depend in part upon the dispatch with which this existing backlog is eliminated.

> Question: Is enough use being made of available military assets for earliest space experimenting?

Looking beyond this immediate problem into the era of large payloads (including men) and the ability to place these payloads in a wide variety

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*See the Space Handbook: Astronautics and Its Applications, Staff Report of the Select Committee on Astronautics and Space Exploration, 85th Congress, second session, pp. 209-216.

of space regions and on the surfaces of the Moon, Mars and Venus, one does not now discern any surplus of mature experiments. Rather, the impression is created that strenuous measures are in order to lay the foundations for an effective science program to exploit these truly enormous capabilities. It may be that very substantial programs of ground research will have to be initiated soon to develop a flow of productive questions to pace the growth of experimental opportunity.

> Question: How can a broad and vigorous research program be stimulated and supported--and at what rate of expenditure--to provide experiments compatible with the large vehicular capabilities already foreseeable?

In order to stimulate suggestions for worthy experiments from the widest possible range of scientific sources, there is need for a systematic way to keep planned space flight capabilities currently before the world scientific community, and thus to invite response. Such disclosure of possible or imminent capabilities must be carried out with due regard for the political impact of "promises made but not kept"; and the development program implied must be firm, and appear firm, with administrative and budgetary support that is strong and clear.

> Question: How should the planned program of space capabilities be conveyed to the scientific community?

It would be wrong to contribute to the impression that the scientist is being asked to justify the long-range program of heavy expenditures for engineering and operating necessities. He should not have to assert that the nation is buying a billion dollars per year of scientific knowledge. The responsibility for this large cost item must at this time rest on government and the people, with the experimental capacities accruing to it being viewed as a scientific opportunity to be used as effectively as possible.

Question: To what extent should the goals of the vehicle development program exceed the clear requirements of established scientific investigations?

Broadly speaking, scientific space exploration can be thought of in the following categories:

a. Free-space
b. Geophysical
c. Lunar
d. Planetary
e. Solar
f. Cosmological

Free-space exploration will consist of measuring and sampling the radiations and sparse matter in the interplanetary regions of the solar system. This activity will probably be characterized by fairly intense initial exploration to establish a general picture of radiations and matter, followed by a comparatively low rate of "patrol" activity to observe variations of environment with time. Free-space exploration will require instrument-carrying vehicles traversing the regions of interest.

Geophysical space research implies observations of the earth itself from an outside vantage point and measurement of the space environment in the general vicinity of the earth. The principal requirements for this research can be served by earth satellite vehicles and an observation station on the moon.

Lunar investigations can be done from the earth, from satellites around the moon itself and, most thoroughly, by men and instruments on the moon.

Planetary investigation is a general class of research within which study of the earth itself is one item. Exploration of the planets, therefore, can be generalized from exploration of the earth--the requirements include satellites about the subject planet and, for those planets with tolerable surface conditions, men and instruments on the subject planet.

Early investigation can take the form of improved telescopic observation from stations in earth satellites and on the moon.

Solar investigations combine the features of free-space exploration (measurement of radiations from the sun) and some features of planetary investigation (observation of the surface of the sun) from stations in earth satellites and on the moon.

Cosmological investigations are concerned with observation of the universe outside the solar system and study of the large-scale processes of nature. The requirements include free-space radiation measurements and observations from stations in earth satellites and on the moon.

These generalizations suggest classes of experimental mechanisms:

a. Instrumented free-space vehicles.

b. Vehicles carrying instruments and men into orbits about, or onto the surfaces of, the planets of the solar system.

c. Scientific stations in earth satellites.

d. Scientific station(s) on the moon.

Advancement of science through space-flight experiments will require expenditure of vehicles and incurring of ground operating costs.

> Question: What level of expenditure (for production of developed flight equipment and operation of ground facilities) should be devoted to flight of scientific instruments?

Advancement of science will also require research and evaluation, by theoretical and laboratory efforts, before and after accomplishment of any flight program.

> Question: What level of expenditure should be devoted to research and evaluation before and after any flight program?

Question: Should the research and development efforts of the non-military part of the national space program be strongly focused on one or a few large-scale goals such as a manned satellite laboratory, a station on the moon, or manned exploration of a planet? If so, at what pace should the program proceed?

In addition to use of space vehicles as tools for research in basic sciences, there is also clear need for flight experiments to advance engineering sciences on which space technology rests. In particular, it will be necessary to test and evaluate engineering materials and devices under space conditions in order to provide the basis for growth of national capabilities in astronautics. Examples are testing of environmental controls, structural materials, seals, lubricants, windows, surface finishes, power supplies, orientation controls, guidance equipment, communication devices, system reliability, etc.

Question: At what level should effort be applied to flight and ground activities for engineering research?

V. INTERNATIONAL COOPERATION IN SPACE ACTIVITIES

The public pronouncements of the U.S. Government on space matters consistently stress the importance of international cooperation in space activities, valued for its own sake as well as for reasons of national security and prestige. The National Aeronautics and Space Act of 1958 (Section 205) authorizes NASA to engage in a program of international cooperation; and NASA has established an Office of International Programs.

Among the opportunities for international cooperation in astronautics, the most readily available important opportunity is that for cooperative efforts between scientists of the U.S. and other countries in exchanging information, devising space experiments and mutually studying the resulting data. One step toward more direct cooperation might be to use U.S. vehicles to carry invited "guest payloads" belonging to foreign institutions.

Opportunities for important political benefits should exist in the need for a world-wide network of sites for tracking, observation, communication, and recovery. These sites need not be viewed simply as an inevitable financial burden on the U.S., but rather as internationally financed sites where close collaboration between American technicians and foreign nationals becomes practicable. Such cooperative efforts would amount to real participation of more than nominal extent by the countries selected. Considerable flexibility can be exercised in selecting the exact locations and the extent of individual facilities for best political advantage.

Launching facilities on foreign soil might also be considered. For example, the U.S. is now basing Intermediate Range Ballistic Missiles in Europe (the United Kingdom and Italy, at present)--the same kind of missiles currently being used for space-vehicle launchings. It may be possible to arrange a cooperative program with any of these countries to prepare space vehicles and launch them from these IRBM bases, the local military hardware being used as the basic equipment. In the United Kingdom, available assets for such an enterprise include trained Royal Air Force launching crews, firing-range facilities in Australia, U.K. rocket developments suitable for the necessary upper stages, and an active space science plan prepared under government auspices. The Italian government could, in a reasonable time, provide suitable equipment and personnel for a similar undertaking.

The kind of satellites now under development for military reconnaissance could, under suitable arrangements, contribute to the implementation of any "open-skies" plan associated with disarmament, arms control, or prevention of surprise attack.

In addition to satellites for observing installations on the earth's surface, need has been suggested for satellites to scan the skies and monitor agreements against testing of nuclear weapons in outer space. These satellites may also have to be supplemented with vehicles in orbit around the sun.

In considering the various possibilities for international cooperation, it should be borne in mind that the same possibilities are open to the U.S.S.R. Using observation sites as an excuse to place Soviet technicians on foreign soil would be entirely consonant with standard Soviet practices. The launching of a satellite from Red China, for example, albeit with Soviet equipment, would have quite an impact on world opinion.

<u>Question</u>: Should the United States take the initiative in joint international support and collective effort?

Programs of cooperation between U.S. and foreign scientists may provide precedents for successful joint work that could carry over into inspection, control, and limitation systems for the regulation of certain space activities in the future.

As the activities of the United Nations on peacetime uses of outer space increase, there will be correspondingly increasing demands upon NASA for participation and preparation.

> <u>Question</u>: How should NASA take an active role in preparation for international negotiations relating to space activities?

Ideally, very large space projects like planetary explorations should be truly world-supported endeavors, involving direct cooperation among the U.S., the U.S.S.R., and others.

> <u>Question</u>: However unlikely the attainment of this ideal of cooperation among the U.S., the U.S.S.R., and others may be, would a proposal along these lines by the United States have more political assets than liabilities?

VI. PUBLIC SERVICE AND COMMERCIAL APPLICATIONS

COMMUNICATION, NAVIGATION, AND METEOROLOGY

Satellites for communication, navigation and meteorology* are under active development for both military and civil purposes. They may ultimately have public service value or might even lead to direct commercial application for profit. In assessing the role of such space devices for public service purposes, cost comparisons with competitive systems may be more important than in military evaluations where other factors may predominate.

Programs of investigation are under way in NASA and industry to clarify the nature and extent of commercial applications of astronautics. Such studies are expressly stated as an objective of the Act (Subsection 102(c), Item (4)) and implicitly authorized for NASA.

Additional applications of a public service nature may flow from operation of observation satellites.** These would include aerial mapping, particularly of remote areas; geological surveys, identifying formation patterns; monitoring of river networks; forest-fire warning; snow surveys; iceberg patrol.

> Question: Are potential civil applications of space systems and technology being adequately investigated?

AMATEURS

The large body of hobbyists in fields relevant to astronautics are a very useful resource worthy of serious official attention. Radio amateurs have provided a good deal of useful data concerning signals from satellites

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*More detailed information on these satellite systems may be found in the Space Handbook, pp. 192-204.

**Space Handbook, pp. 171-191.

launched to date; and numerous non-professional astronomers have participated in the "Moonwatch" system for optical observation of satellites. These patient and often skilled observers can be of increasing usefulness if provided with proper information and a central data clearing house. In addition there are, as estimated by the American Rocket Society, about 10,000 amateur rocket experimenters--and 162 of them were injured in a recent six-month period. The enthusiastic interest behind these experiments could well be encouraged, but should also be the subject of a systematic effort to arrive at the intended result at a lower level of bodily hazard.

<u>Question</u>: To what extent should NASA provide for this segment of public interest?

ACCOUNTING AND CHARGING FOR ECONOMIC BENEFITS

Although it may not now be possible to fix a timetable for specific economic applications of space activity, it can be predicted with some confidence that they will occur, that they will begin within a few years, and that they will be substantial.

On the assumption that the economic benefits derived from space activities, and the differential cost of effort devoted to securing those benefits, are or will become partly expressible in dollar equivalents, the question is raised of accounting and charging appropriately for them. At least preliminary consideration could be given to several conceivable methods of handling the matter.

If the Federal Government conducts certain space activities that yield economic benefits and does not attempt to segregate the expense or impose a charge for use, the cost is in effect being defrayed by general revenues, principally from taxation. This may be regarded as tantamount to a subsidy in favor of the users at the expense of the non-users, if any. Such a method may be considered appropriate if the benefits are believed to be incapable of arithmetic apportionment or if they are believed to be so widespread that allocation of charges would be unnecessary or inefficient.

Certain of the communications services now contemplated may lend themselves to specific charges for use, on the analogy of the Post Office; that analogy of course need not prejudge the question of whether the operation should be conducted in principle with the intention of turning a profit. Specific charges for use, however, imply the power of the public authority to monitor and control the conditions of use; some forms of space communication, which may as a technical matter be available without resort to government-controlled facilities on the ground, perhaps cannot yield revenue in the form of specific charges unless a reporting scheme, backed by enforceable sanctions, can be devised. If a passive reflector, launched for research purposes, can be used for signal relays by any one of an indefinite number of users within and without the United States, the government might give thought to the political desirability of publicly dedicating the reflector as an international free object, furnishing information on orbital elements and suggestions for optimum use.

In some economic applications of space, the Federal Government will be joined, assisted, and perhaps in time supplanted by private enterprise. Communications companies have expressed interest and begun to explore the possibilities of space relay and reflector systems. It will be necessary to arrive at government-industry agreements, probably concluded in several phases, apportioning research and development functions, costs, risks of failure and accident, and (ultimately) responsibility for operation, as well as monetary recovery from the public.

Consideration of some of the problems of this kind may be postponable. It should not, however, be restricted by reference to the present statutory limits of the jurisdiction of NASA. Once an economic benefit from a space activity is shown to be feasible as a result of research, development, and demonstration in operation, NASA's statutory mission as presently worded would seem to be discharged with respect to that particular application. Permanent operation of a space facility for commercially practicable use would seem to be outside NASA's present authority except to the extent that research and development problems are involved. Likewise, NASA's present authority would not seem to extend to the regulation of public-utility-type activities connected with outer space. Recommendation of legislation to lodge extensive operating authority or regulatory authority in some Federal Government organ, whether NASA or some other existing agency or a new agency, seems to be an appropriate subject for NASA's consideration at a proper time.

Question: What, if anything, should be done to encourage more active interest in commercial space systems by private enterprise?

VII. WORLD-WIDE GROUND FACILITIES

To accomplish all planned space flight programs, it will be necessary to have world-wide facilities for launching, tracking, communication, computation and recovery.*

The following brief outline is intended to serve as a qualitative reminder of (a) the total magnitude of the national investment, (b) the overlapping nature of the civil and military requirements, and (c) the implications for international cooperation.

Actual costs and other detailed data concerning ground facilities should be obtained directly from the responsible agencies.

A joint DOD-NASA committee has made an inventory of all existing facilities, as well as of all military and NASA programs requiring facilities, to determine where gaps exist and to prevent duplication.

LAUNCHING AND TEST FACILITIES

At the present time major missile test facilities are located at:

- Atlantic Missile Range (AFMTC, Patrick AFB)
- Pacific Missile Range (Point Mugu, Vandenberg AFB)
- Eglin Gulf Test Range (Tyndall AFB)
- White Sands Missile Range (Holloman AFB)

None of these facilities as presently constituted can accommodate the larger launching rockets presently planned. Also, existing facilities could not accommodate large vehicles using nuclear propulsion or some chemical propellants because of contamination problems. Thus, the extensive modification of existing facilities and the establishment of new, remote facilities

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*See Space Handbook, pp. 138-139.

will probably be required, raising considerable problems in logistics and the acquisition of suitable real estate.

> Question: Should efforts to develop large chemical and nuclear rockets be supplemented now by arrangements for acquiring real estate for a large launching facility in a remote region?

TRACKING FACILITIES

The network of observation, tracking, and communication stations should eventually be adequate to permit continuous contact with vehicles from the time of launch.*

The following is a summary of present tracking facilities, including certain of the planned expansions:

MOONWATCH STATIONS

Location	Number	Location	Number
United States	42	Canada	1
Union of South Africa	12	Philippine Islands	1
Germany	7	Taiwan	1
Japan	88	Australia	3
Wake Island	1	Guatemala	1
Guam	1		

These stations lie between latitudes 52.5° North and 35° South.

To accommodate vehicles using polar orbits or orbits inclined more than 50° to the equator, additional Moonwatch stations closer to the polar regions would be required.

Of all the tracking facilities, these stations are the simplest to equip and operate. Equipment is usually no more elaborate than a small satellite

*Space Handbook, pp. 74-76, 80-82.

tracking telescope and a radio receiver tuned to a time standard. The station can be operated by two people.

Baker-Nunn Facilities

The mainstay of the long-range optical tracking program is a world-wide network of precision photographic stations which use Baker-Nunn cameras.

There are twelve Baker-Nunn stations between latitudes 45° North and 30° South, located at:

White Sands, New Mexico	Shiraz, Iran
Woomera, Australia	Curacao, Netherlands West Indies
Cadiz, Spain	Palm Beach, Florida
Mitaka, Japan	Villa Dolores, Argentina
Naini-Tal, India	Haleakola, Hawaii
Olifantsfontein, South Africa	Arequipa, Peru

The precise photographic reduction takes place at Cambridge, Mass., where special precision measuring devices are used.

As in the case of the Moonwatch stations, this network will require expansion to track vehicles on near-polar orbits.

Minitrack Stations

These radio tracking stations were set up as a part of the Vanguard Satellite Project.

At present there are twelve stations between latitudes 38.5° North and 34° South, located at:

Antigua, British West Indies	Batista Field, Havana, Cuba
Mayaguana Island	Quito, Ecuador
Grand Turk Island	Lima, Peru
San Diego, California	Antofagasta, Chile
Blossom Point, Maryland	Santiago, Chile
Ft. Stewart, Georgia	Woomera, Australia

Present plans call for establishing additional stations in Alaska, Newfoundland, Spain, and the United States. A Minitrack station requires about 23 acres of level land.

Deep-Space Stations

In order to perform continuous tracking of an interplanetary vehicle, at least three suitably located tracking facilities will be required.

At the present time the tracking facility at Goldstone is the only one in the U.S. which is adequate for tracking deep-space probes. The tracker consists of a movable antenna 85 feet in diameter and sensitive receivers for tracking signals transmitted by a space vehicle.

Present NASA plans call for two new facilities, located in South Africa and Australia.

COMMUNICATION FACILITIES

To accomplish various space missions involving both manned and unmanned vehicles on many different trajectories, it will be necessary to have adequate systems for communication between the space vehicle and ground stations, between ground stations, and between the ground stations and control or computation centers.

To obtain continuous communication for Project Mercury it will be necessary to use shipboard stations in the Pacific and Indian Oceans, as well as land stations.

COMPUTATIONAL FACILITIES

The information obtained from each network mentioned must be processed by one or more computers, and any new launching or tracking facility will require access to a suitable computation center.*

*Space Handbook, pp. 82-83.

Computer facilities generally require air conditioning, special power supplies, dust-free and moisture-free housing, fairly elaborate checkout and maintenance equipment, and a considerable body of trained personnel.

RECOVERY FACILITIES

Every space flight program involving manned vehicles, or vehicles carrying packages that are to be returned to the earth's surface, will require recovery facilities.

For manned systems, the recovery plans and equipment will necessarily be quite elaborate in order to insure adequate safety. The recovery equipment will generally involve ships, aircraft and considerable manpower.

Question: Is the program for construction and operation of ground facilities in proper balance with the military and non-military program for development and operation of vehicles?

Question: What part of the costs for construction and operation of ground facilities can be properly charged to the non-military part of the national space program?

VIII. VEHICLES

LAUNCHING VEHICLES

The nation's astronautics assets in vehicles are, at present, chiefly the products of military programs.

Vehicle developments fall into four general categories:

1. Minor modification of items already developed in military programs (e.g., WS-117L).
2. Extension, by supplementary development, of capabilities of basic items from military programs (e.g., Atlas/Vega).
3. New developments based on use of components developed by the military (e.g., Saturn).
4. Essentially new developments (e.g., Nova).

> Question: How much effort should be applied to presently understood launching-vehicle development possibilities in these categories to serve the objectives and needs of the national space program?

The general trend of possibilities is indicated in Table 1 and Fig. 1. Since all of the payload figures and first-flight-test dates may not correspond exactly to the latest official planning, the responsible agencies should be consulted for confirmation, revision, or fuller discussion of these details. Cost figures and other program details are also best obtained from the agencies and contractors concerned.

The capabilities of the various vehicles have been summarized in Table 1 with reference to a standard capability--that of placing a satellite payload on orbit 300 miles above the earth's surface. This standard capability is related to other interesting payload figures for a given rocket assembly by the curve of Fig. 2.

Table 1

SUMMARY OF SPACE VEHICLE CAPABILITIES

Vehicle Name	Summary Description	Reference Payload Capability for 300-mi Orbit (lb)	First-Flight Date[a]	Remarks
Vanguard	3-stage satellite vehicle designed for I.G.Y.	20-50	12/6/57 3/17/58	First test. First orbit.
Jupiter C	4-stage vehicle: modified Redstone booster and 3 stages of small solid rockets	20	3/-/56 1/31/58	First flight as ballistic missile. First U.S. satellite (Explorer series).
Juno II	4-stage vehicle: modified Jupiter IRBM and 3 stages of small solid rockets	100	12/6/58	Pioneer III.
Thor/Able	2-stage vehicle: Thor IRBM booster and Vanguard second stage	200	4/-/58 10/11/58	First flight as ballistic missile. First flight as Pioneer I (with added stage of solid propellant).
Thor/Hustler	2-stage vehicle: Thor IRBM and Hustler (WS-117L) stage	400	2/28/59	First flight as Discoverer I with 245-lb payload.
Thor/Delta	3-stage vehicle designed for lunar and space probe: Thor/Able and third stage (similar to Pioneer I)	500	Early 1960	Extension of Thor/Able program.
Atlas	1-1/2-stage ICBM modified for SCORE satellite and Mercury booster	150	12/18/58	Orbit--Project SCORE.

(Cont'd.)

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Table 1 (Cont'd.)

Vehicle Name	Summary Description	Reference Payload Capability for 300-mi Orbit (lb)	First-Flight Date[a]	Remarks
Atlas/Able	Atlas 1-1/2-stage booster combined with Vanguard second stage	2200	6/-/59	Scheduled date cancelled. Designed as space probe with 50-lb payload.
Atlas/Hustler	Atlas 1-1/2-stage booster with Hustler (WS-117L) upper stage	3100	Late 1959-Early 1960	Combination selected for WS-117L satellite.
Atlas/Vega	Atlas booster combined with new development using Vanguard first-stage engine (Atlas is modified to accept 10-ft-diameter upper stage)	5000	Fall 1960	Schedule date.
Atlas/Centaur	Modified Atlas (as above) combined with high-energy Centaur stage (lox-hydrogen)	8000	Mid-1961	Schedule date.
Saturn	Clustered tanks and engine assy. forming first stage (8 188,000-lb-thrust engines with 1 Jupiter tank and 8 Redstone tanks) combined with modified ICBM as upper stages	19,000	Mid-1962	Planned date (ARPA development).
Advanced Saturn	As above with high-energy upper stage	30,000	Mid-1963	Estimated date (not programmed).

(Cont'd.)

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Table 1 (Cont'd.)

Vehicle Name	Summary Description	Reference Payload Capability for 300-mi Orbit (lb)	First-Flight Date[a]	Remarks
Nova	Clustered 1,500,000-lb-thrust engines (no air-frame design)	150,000	Mid-1965	Planned date (engine development program--ARPA).
Scout	4-stage solid-propellant missile using modifications of Polaris-Sergeant-Vanguard II motor developments	150	Early 1960	
Titan X	2-stage Titan plus small third stage	3000	Early 1960	Estimated.
Advanced Titan X	2-stage modified Titan plus small third stage	8000	1963	Estimated.
Clustered Atlas	3-stage vehicle: 3 Atlas (clustered) plus Atlas and Centaur	31,000	1964	Estimated.
Clustered Titan	4-stage vehicle: 4 Titan I (clustered) plus Titan I, Titan II, and Centaur	33,500	1964-1965	Estimated.
Clustered Thor	4-stage vehicle: 7 Thor (clustered) plus Titan I, Titan II, and Centaur	29,500	1964	Estimated.

[a]Dates when system functions reliably may be well beyond scheduled first-flight dates.

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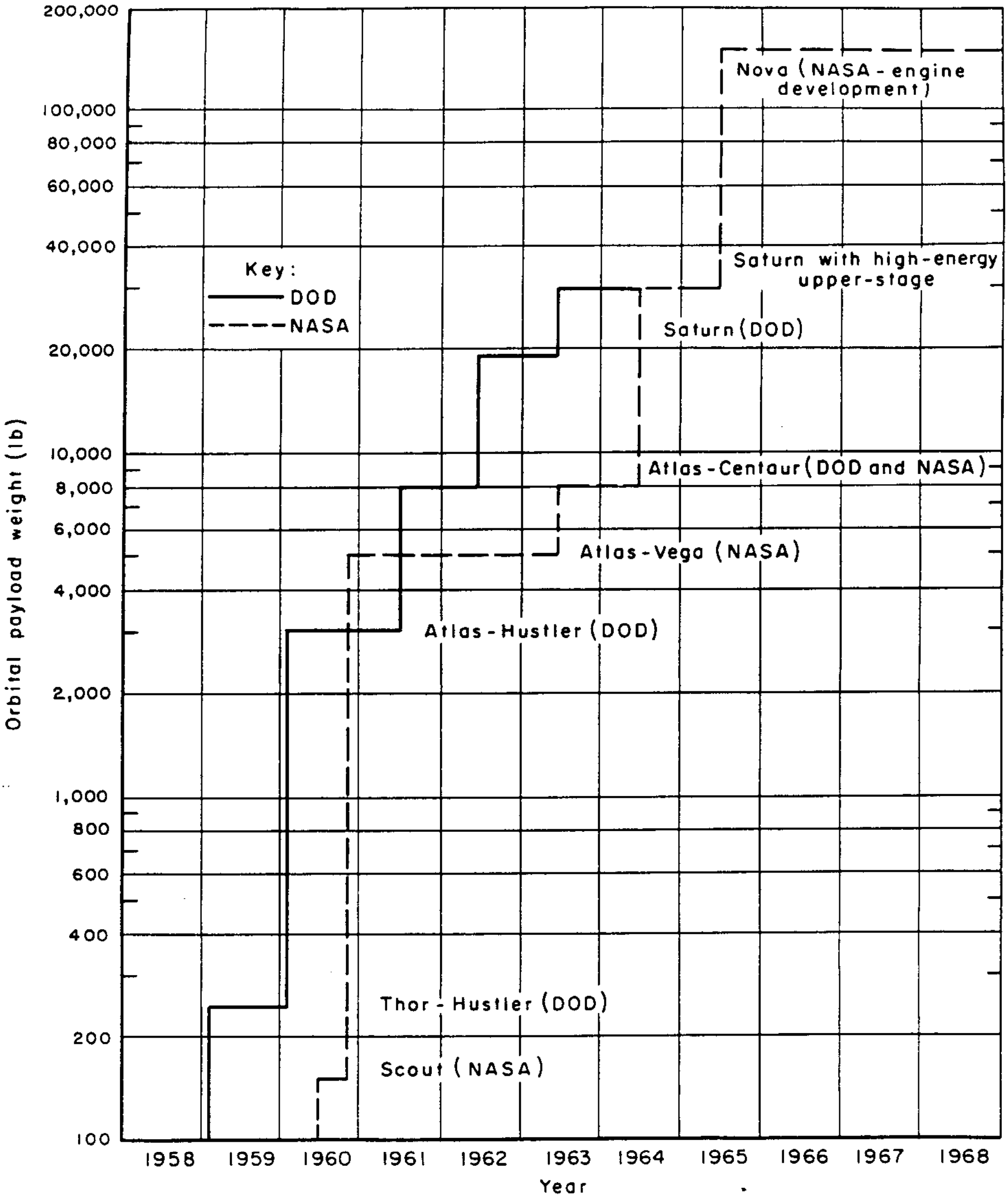

Fig. 1 — U.S. planned space capability
(based on 300-mile orbit)

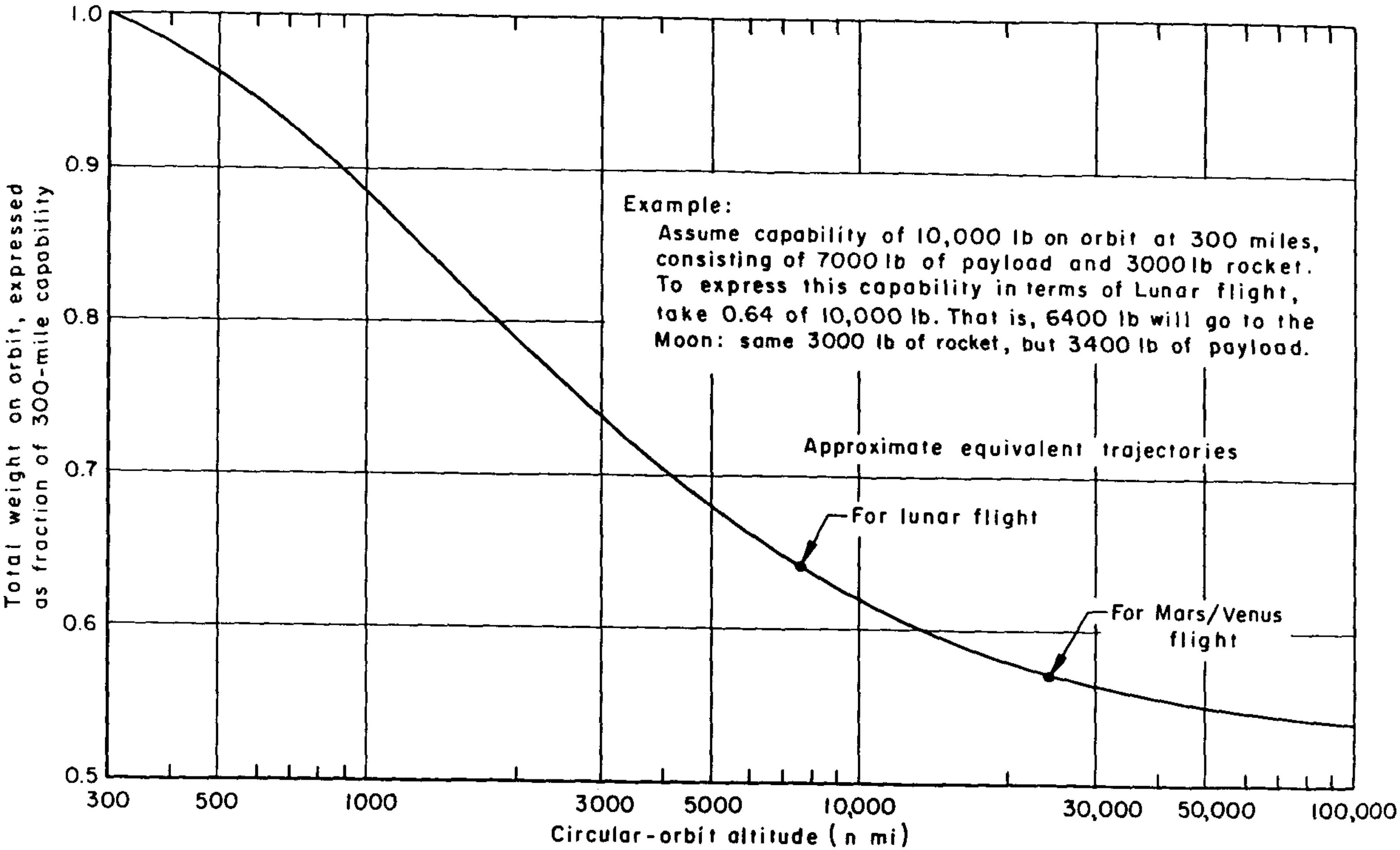

Fig. 2 — Conversion chart for space vehicles

It should be carefully noted that the dates listed on Table 1 are dates on which a first flight test is scheduled. The time when a system can be said to function with reasonable reliability may be--and commonly is--well beyond this first test date.

The number of flight test vehicles required to bring a system to operational readiness is a highly variable and indefinite matter, as the data in Table 2 indicate.

PAYLOAD CARRIERS

In addition to the launching vehicles there are others that actually house the payloads; these are literally space vehicles.

The payload carriers for Explorer and Vanguard cost comparatively little, although they required a long time for development. But the payload carriers for Sputnik III and for Discoverer represent major undertakings.

Several programs now in development involve large, complex, and expensive payload carriers: specifically, Project WS-117L (Reconnaissance Satellite), Dyna-Soar (Manned Aerospace Global Glider), and Project Mercury (Manned Satellite). These programs, which represent heavy national investments, require not only that the space vehicle be large, but also that it include complete provisions for such items as internal power, control of environment and orientation, and communication.

These three programs portend the larger space vehicles that will have to be developed for use with the large launching rockets currently programmed. It seems quite likely that the time and money required to develop and produce the larger payload carriers (particularly manned vehicles) will be comparable with the time and money required to develop and produce the launching rockets.

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Table 2

SUMMARY OF U.S. MISSILE FIRINGS (R AND D)

Successful firings expressed as cumulative totals

Flight Number	Single-Stage Missiles: Redstone	Thor	Jupiter	Atlas	Titan	Multistage Missiles: Atlas (2 Stages)	Thor-Able (2 Stages)	Thor-Hustler (2 Stages)	Vanguard (3 Stages)	Explorer-Jupiter C (4 Stages)
1	1	0	0	0	1	0	0	1	0	1
2	2	0	0	0	2	1	1	2	0	2
3	2	0	1	1	3	2	2	2	1	2
4	3	0	2	2	4	3	2	2	1	3
5	4	1	3	2		3	3		1	4
6	5	1	3	2		4	4		1	4
7	6	1	3	2		5	5		1	4
8	7	2	4	3		6	6		2	
9	7	2	5			7	7		2	
10	7	3	6			7			2	
11	8	3	6			8				
12	9	3	7			9				
13	10	3	8			9				
14	11	4	9			9				
15	12	5	10			9				
16	13	6	11			9				
17	14	6	12			9				
18	14	6	13							
19	15	6	14							
20	16[a]	7[a]	15							
Score[b]	34/42	19/33	15/20	3/8	4/4	9/17	7/9	2/4	2/10	4/7

[a]Column incomplete.
[b]Successes/attempts as of June, 1959.

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Of course, the large-payload-carrier development program must be accompanied by a program of research to define projected space missions and determine the nature and characteristics of the payloads by which they may be accomplished. This research, and the subsequent design and testing of payload equipment, may require long periods of time.

<u>Question</u>: Is proper emphasis being placed on development of payloads and payload carriers for use with the large launching rockets now in development?

IX. SOURCES OF INFORMATION

It is suggested that reference be made to National Aeronautics and Space Act of 1958, Conference Report No. 2166, House of Representatives, 85th Congress, 2nd Session, July 15, 1958, as a summary of the Act establishing NASA, and a brief outline of the apparent intent of the Congress in this Act.

While many documents are available concerning the technical aspects of astronautics, use has been made in this report of a single source: Space Handbook: Astronautics and Its Applications, Staff Report of the Select Committee on Astronautics and Space Exploration, 85th Congress, 2nd Session, 1959, as a basic unified reference.

In addition to the NASA staff, the following sources of detailed information on the various areas of interest are suggested. It should be emphasized that this list is by no means exhaustive.

Source	Type of Information
Department of Defense	
1. Director, Defense Research and Engineering	Relations of military research and development in space technology to the general research and engineering program of the Department of Defense
2. Director, Advanced Research Projects Agency	General summary of military space programs and plans
3. Chairman, Civilian-Military Liaison Committee	Operation of the C-MLC
4. Joint Advance Study Group, Joint Staff, Joint Chiefs of Staff	Future military operations in space
5. Department of the Army	Army plans and interest in space activities
6. Department of the Navy	Navy plans and interest in space activities

7. Department of the Air Force	Air Force plans and interest in space activities
8. Commander, Air Research and Development Command	Dyna-Soar Program
9. Commander, Air Force Ballistic Missile Division, Air Research and Development Command	Air Force ballistic missile and space activities; reconnaissance satellite project WS-117L
10. Director, Development Operations Division, Army Ballistic Missile Agency	Requirements for engineering test and evaluation in space; Army ballistic missile and space activities
11. Commander, Pacific Missile Range	Launching facilities and operations
12. Commander, Atlantic Missile Range	Launching facilities and operations
13. Air Force Special Weapons Center	Facilities requirements for nuclear rockets
14. Naval Research Laboratory	Navigation satellites
15. Chief of Engineers, Army Corps of Engineers	Value of satellite observations to river monitoring

Department of State

1. Office of the Special Assistant to the Secretary for Disarmament and Atomic Energy	Development of international agreements on control and operation
2. Office of Political Affairs, Bureau of United Nations Affairs	U.S. participations in, and commitments to, United Nations space proceedings

Department of Commerce

1. Director of Research, United States Weather Bureau	Meteorological satellites; economic aspects of weather forecasting
2. Director, U.S. Coast and Geodetic Survey	Value of satellite observations to aerial mapping and geodetic surveys

Department of Agriculture

1. Chief Forester, U.S. Forest Service	Value of satellite observations to forest-fire monitoring

Department of the Interior	
1. U.S. Geological Survey	Value of satellite observations to geological surveys
Treasury Department	
1. Headquarters, U.S. Coast Guard	Value of satellite observations to iceberg patrol
Central Intelligence Agency	
1. Assistant Director for Scientific Intelligence	USSR space activities, capabilities, plans, and organization
Atomic Energy Commission	
1. Director, Los Alamos Scientific Laboratory	Use of space vehicles for monitoring nuclear weapon tests in space; nuclear rockets - Rover program
United States Information Agency	
1. Office of Research and Intelligence	Apparent public attitudes toward space activities
National Science Foundation	
1. Director, National Science Foundation	Possibilities and problems of scientific research in space; avenues for international collaboration in space sciences
National Academy of Sciences	
1. President, National Academy of Sciences	Possibilities and problems of scientific research in space; avenues for international collaboration in space sciences
2. Chairman, United States National Committee for the International Geophysical Year	International cooperation in large scientific enterprises
3. Chairman, Space Sciences Board	Space sciences program
Industry and Other Institutions	
1. Director, Jet Propulsion Laboratory, California Institute of Technology	Status of space technology and prime needs for advancement

2.	Executive Vice President, Space Technology Laboratories	Status of space technology and prime needs for advancement
3.	Manager, Astronautics Division, Convair Division of General Dynamics Corporation	Atlas ballistic missile and its potential for space applications
4.	Vice President and General Manager, Denver Division, The Martin Company	Titan ballistic missile and its potential for space applications
5.	Vice President - Missiles, Douglas Aircraft Company	Thor ballistic missile and its potential for space applications
6.	General Manager, Missile Division, Chrysler Corporation	Jupiter ballistic missile and its potential for space applications
7.	Vice President and General Manager, Missiles and Space Division, Lockheed Aircraft Corporation	Reconnaissance satellite project WS-117L and its potential for further space applications
8.	Vice President and General Manager, Rocketdyne Division, North American Aviation, Inc.	Large rocket engine status
9.	Vice Presidents, Liquid and Solid Rocket Divisions, Aerojet-General Corporation	Large rocket engine status
10.	American Telephone and Telegraph Company	Commercial applications of communication satellites

MEMORANDUM ON THE NEED FOR A STUDY TO DEVELOP A SUPPORTABLE POSITION ON RATE AND SCALE IN SPACE RESEARCH

(from T. Keith Glennan, June 19, 1959)

The Problem

To identify national objectives to be served by a program of non-military space activities, to suggest the magnitude and scope of the program required to attain those objectives, and to determine the balance of emphasis to be placed on various phases of the program in both the short and long term future.

Background Information

The following statements are believed to reflect the conditions that presently exist as a background against which NASA is attempting to develop and carry out the national program of non-military space activities:

a. While the military departments have had an interest in the use of the space environment for several years, public and governmental acceptance of this field of research and application is of very recent origin and of questionable depth. Indeed, that acceptance was born in a semi-hysterical response to the accomplishments of the USSR in this field--not from the conviction that this new frontier presented a challenge and an opportunity for useful and beneficial human activity.

b. We are becoming increasingly conscious of the enormous technical difficulties that face us in this field. It is apparent that very large sums of money and substantial numbers of highly trained research and development people would be required to make maximum or even substantial progress in the next decade in each promising area. To achieve such progress would require a diversion of resources of such magnitude as to constitute a crash effort. And yet, in the non-military areas, it is not clear that a crash program is warranted or, indeed, would be substantially more productive than a well-planned, orderly and determined approach to the solution of the problems that face us.

c. Inputs to the presently delineated program in NASA have come mainly from the Space Science Board of the National Academy and from our own groups. Much has been accomplished because of the impetus given to the program by enthusiastic scientists seeking new and exciting fields to conquer. But the realities of budgetary restrictions and problems of organizational development and the housing of people and activities suggest a more comprehensive approach. The sheer magnitude of the impact of space programs on the budget makes the space effort a matter of public policy which deserves and requires the attention of top flight non-scientific thinking.

d. Rational planning and implementation of an orderly program for the development of the devices and facilities (booster and vehicular systems, tracking nets, launch and range facilities) which must undergird any on-going program is proving to be both expensive and time consuming. As a result, it has been necessary to slow down the undertaking of research in space to such an extent that we face the prospect of losing the enthusiasm that must be present if progress is to be made.

e. Facilities for these programs, including launching, tracking, data acquisition, and R & D facilities must be world-wide in extent and will be expensive to build, to maintain and operate. A minimum level of research effort would seem to be required to justify the investment in money and management necessary to provide these facilities.

Discussion

The Department of Defense has adopted and is pursuing a course which recognizes space as merely one additional environment in which to utilize devices and systems to accomplish one or more military objectives. From a military standpoint, this viewpoint would seem to have merit. Pursued to its logical conclusion, space activities in the Department of Defense would then compete for money with other methods of accomplishing military objectives.

The NASA has been given broad responsibility for research, development, and exploration in aeronautics and space. Reserved to the DOD are those activities which are "peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States)." The parenthetical clause appears to permit research and development by the DOD in almost any area of its choosing, and thus it is probably not feasible to attempt to fix a hard and fast line between the research and development activities of NASA and DOD in the space field. Establishment of "military requirements" sets a degree of urgency that may or may not be realistic but which strongly affects the method of attack and the rate at which progress is attempted.

The end objectives of the NASA program, much of which will support military objectives in space, have less popular and Congressional appeal than most of the military programs. And yet, it appears that a vigorous civilian program must quickly move to a budgetary level of more than one billion dollars annually. What then is or what should be the level of effort applied by NASA and what is the rationale that will support such a level, whatever it may be?

It seems clear that we now have enough experience to examine more adequately the economic, sociological, and political aspects of space activities and that the probable course of scientific activity can be more sensibly predicted than was the case eighteen months ago. Accordingly, it should be possible to develop a rationale that could be supported by the Administration and the Congress and on which there could be developed a sound and well balanced program of non-military space activities. It should also be possible to discover a better method for determining the relationship of NASA's efforts to those of DOD than presently exists.

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